RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #15

Review of and Proposed Changes to Appendix L: Integrity

Presented by William Harman

SUMMARY

I have reviewed Appendix L, which is on the subject of integrity, to determine whether it should be modified to conform to the MOPS revision. I see that several explanatory sentences should be added. A proposed draft is included in this working paper.

Review of Appendix L, Integrity

I have reviewed Appendix L, which is on the subject of integrity, to determine whether it should be modified for this version of the MOPS. I believe that it would be useful to add some explanations to help the reader understand the relationship between these results and the new MOPS requirements. Following is my proposal for a revised Appendix L, using yellow highlighting to show the new material.

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Appendix L. Impact of Radio Frequency Interference On Extended Squitter Report Integrity

(editorial note -- delete subtitle)

ADS-B system integrity is defined in the MASPS (RTCA DO-242A, section 3.3.6.5) in terms of the probability of an undetected error in a report received by an application, given that the transmitting ADS-B system participant is supplied with correct source data. An important component of ADS-B integrity is attributable to radio interference, whose effects are largely controlled by the use of error detection and correction applied upon reception. Several different techniques for error detection and correction have been considered, including the techniques currently used in TCAS (defined in the TCAS MOPS, RTCA DO-185A) and several new techniques, described in Appendix I. The rate of undetected errors is a key consideration in the development of new techniques, because of the inherent trade between undetected error rate and reliable acceptance of signals. Analysis and simulation have been used by two organizations to evaluate performance in terms of undetected error rate in a number of cases. Results of these evaluations, carried out for the Los Angeles interference environment, are summarized in Table L-1 and shown in more detail in Figure L-1. From the results in the table, it has been concluded that the undetected error rate increases as receiver MTL is reduced, and that the conservative error correction technique and the enhanced error correction technique are effective in controlling the error rate. As a result, the MOPS standards now require conservative error correction or enhanced error correction for all classes other than A0. Note, therefore, that some of the rows in Table L-1 are hypothetical combinations which are not allowed by this MOPS.

Table L-1: Undetected Report Error Rate

Receiver MTL (referred to antenna)	Reception and Error Correction Techniques	Evaluated contribution to undetected error rate (per report)	
		William J. Hughes Technical Center, FAA	MIT Lincoln Laboratory
MTL = -72 dBm	DO-260 reception techniques DO-260 error correction	0.09 x (10^{-6})	0.08 x (10^{-6})
MTL = -74 dBm	DO-260 reception techniques DO-260 error correction	0.15 x (10^{-6})	1.4 x (10^{-6})
MTL = -79 dBm	DO-260 reception techniques DO-260 error correction	1.4 x (10^{-6})	3.9 x (10^{-6})
MTL = -84 dBm	DO-260 reception techniques DO-260 error correction	5 x (10^{-6})	10.1 x (10^{-6})
	DO-260 reception techniques Conservative error correction	N/A	< 0.01 x (10^{-6})
	Enhanced reception techniques Enhanced error correction	N/A	0.05 x (10^{-6})

N/A denotes not available within the scope of work.

Note: *RTCA DO-260A specifies that Class A1, A2 and A3 Receiving Subsystems (i.e., MTLs of –79dBm and –84 dBm) require enhanced reception techniques and enhanced error correction.*

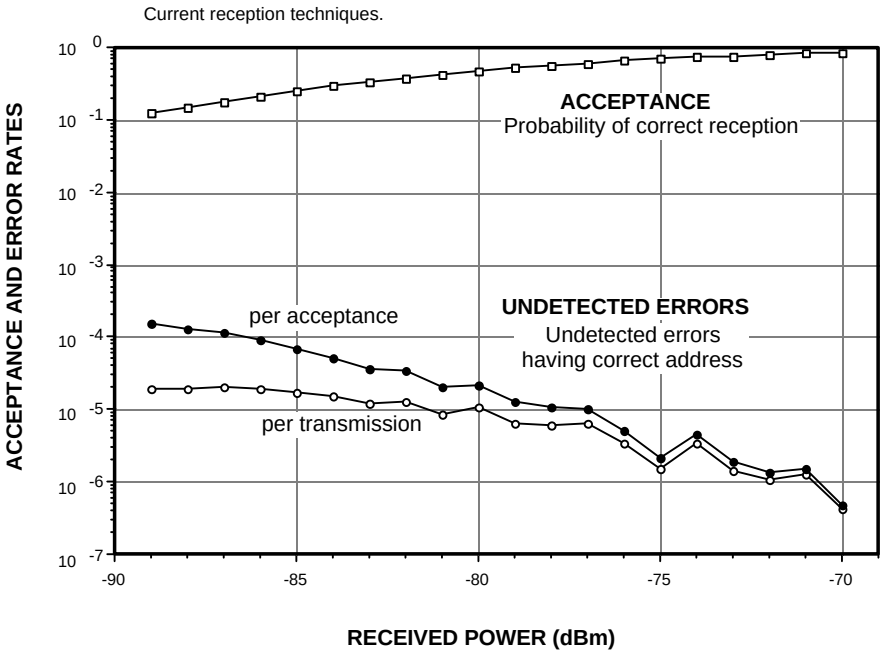

Figure L-1: Simulation Results Giving Acceptance Probability and Undetected Error Rate.

Based on the results in Table L-1, which show that lower MTL is associated with higher error rates, a more detailed study was undertaken, producing the results in Figure L-1. Reception rates are shown here as a function of received power level, giving both acceptance of valid signals (the upper curve) and undetected errors (the lower curves). A Monte Carlo simulation was used to obtain these results. The data in the figure is limited to the current reception techniques, which do not have the benefit of conservative or enhanced error correction. Otherwise the error rates are much lower, and it is more difficult to assess performance using the Monte Carlo technique.

More specifically, the upper curve shows the probability of correct signal acceptance, including the effects of error detection and correction. The lower curves represent the probability that an undetected error occurs and is reflected in an ADS-B report. Simulation results are shown here in two forms, normalized to the transmission rate in the lower curve, and normalized to the reception rate in the middle curve. The results show a clear trend in which the error rate, expressed either way, degrades as received signal power decreases. This behavior is consistent with the results in Table L-1. Together they underscore the need for the additional performance requirement when receiver MTL is enhanced relative to TCAS receivers.